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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/002,862	11/15/2001	John Davis Holder	MEMC 01-0650 (3003)	4783
321	7590	01/07/2005	EXAMINER	
SENNIGER POWERS LEAVITT AND ROEDEL ONE METROPOLITAN SQUARE 16TH FLOOR ST LOUIS, MO 63102			SONG, MATTHEW J	
			ART UNIT	PAPER NUMBER
			1765	

DATE MAILED: 01/07/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/002,862

Applicant(s)

HOLDER, JOHN DAVIS

Examiner

Matthew J Song

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 18 October 2004.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-102 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-102 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
 - ☐ Certified copies of the priority documents have been received in Application No. _____.
 - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____ |

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DETAILED ACTION

Claim Rejections - 35 USC § 102

1. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

2. Claims 1-3 are rejected under 35 U.S.C. 102(b) as being anticipated by Nagai et al (US 5,902,395).

Nagai et al discloses forming a partially melted charge in a crucible and the partially melted charge comprises molten silicon and unmelted polycrystalline silicon, where the unmelted polycrystalline silicon has an exposed surface above the upper surface of the molten silicon 2 (Fig 3 and col 5, ln 5-35). Nagai et al also discloses rotating the crucible at a rate of 1 rpm (col 6, ln 1-67 and col 13, ln 20-25). Nagai et al teaches forming an unmolten layer, which consists of silicon granules on a silicon melt and silicon granules in a feed tube (Fig 3). Nagai et al also discloses the feeding of granular polysilicon from a feed to the feed pipe is repeatedly commenced and stopped so as to maintain the stagnation of the granular silicon material (Abstract and col 13, ln 5-15), this reads on applicant's step c comprising feeding additional polycrystalline silicon into the rotating crucible by intermittently delivering the additional polycrystalline silicon onto the exposed unmelted polycrystalline silicon. Nagai et al also discloses the unmolten layer is melted and granular silicon material is supplied onto the unmolten layer via the feed pipe (col 11, ln 10-20), this reads on applicant's melting the

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unmelted polycrystalline silicon and the additional polycrystalline silicon to form the silicon melt. Nagai et al also teaches manufacturing a plurality of silicon monocrystals using a single crucible according to the Czochralski method by forming an unmolten layer on a silicon melt and feeding additional polycrystalline silicon intermittently (claims 5-6), this reads on applicant's melting polycrystalline silicon in the crucible from which the single crystal ingot is grown.

Referring to claim 2, Nagai et al teaches a crucible having a diameter of 18 inches (col 13, ln 10-15) and rotating the crucible at 1 rpm (col 13, ln 20-25).

Referring to claim 3, Nagai et al teaches a crucible having a diameter of 18 inches (col 13, ln 10-15) and rotating the crucible at 1 rpm (col 13, ln 20-25). Nagai also teaches a layer of unmolten polycrystalline silicon, which inherently has a center and width, and feeding granular silicon to the unmolten layer such that a constant thickness of the unmolten layer is maintained (col 5, ln 25-40), this reads on applicant's maintaining the width of the exposed unmelted polycrystalline silicon.

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

4. Claims 1-102 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nagai et al (US 5,902,395) in view of Holder et al (US 5,588,993).

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Nagai et al discloses all of the limitations of claim 4, as discussed previously, except the interface between the unmelted polycrystalline silicon and the upper surface of the molten silicon is approximately equidistant from the center of the unmelted polycrystalline silicon.

In a method of preparing a molten silicon melt, note entire reference, Holder teaches polycrystalline silicon **10** is loaded into a crucible **20** and chunk poly crystalline silicon is used because using chunks avoids the formation of void defects (col 3, ln 35 to col 4, ln 2). Holder also teaches polycrystalline silicon **10** is melted until a partially melted charge forms in a crucible (col 4, ln 30-65). After forming the partially melted charge in the crucible, granular polycrystalline silicon **40** is fed onto the exposed unmelted polycrystalline silicon (col 5, ln 1-60). Holder also teaches feeding the polycrystalline silicon **40** on the unmelted silicon **11** allows the silicon to dehydrogenate, which is desirable (col 5, ln 10-30). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Nagai with Holder's method of feeding polycrystalline silicon onto the exposed unmelted polycrystalline to allow the polycrystalline silicon to dehydrogenate before becoming immersed in the molten silicon, which is desirable (col 3, ln 1-15).

Referring to claim 4-5, the combination of Nagai et al and Holder teach the interface between the unmelted polycrystalline silicon and the upper surface of the molten silicon is approximately equidistant from the center of the unmelted polycrystalline and equidistant from the interior wall of the crucible ('993 Fig 3).

Referring to claims 6-8, the combination of Nagai et al and Holder teach 55 kg of chunk polycrystalline for a 100 kg total charge ('993 col 5, ln 5-15); therefore the percentage of chunk

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polycrystalline can be determined to be 55% (55/100), which reads on applicant's range of 50-60%.

Referring to claim 9-10, the combination of Nagai et al and Holder teaches the molten silicon comprises about 25-50% of the total surface area ('993 col 4, ln 45-65 and Figs 2-4), this reads on applicant's d ranges about 65%-85% of D.

Referring to claim 11-12, the combination of Nagai et al and Holder teach rotating the crucible at 1 rpm ('395 col 13, ln 20-25).

Referring to claim 13-14, the combination of Nagai et al and Holder teach rotating the crucible at 1 rpm ('395 col 13, ln 20-25), but does not teach rotating at about 2.1 rpm. The rate of crucible rotation is dependant on the flow rate of the feed pipe. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Nagai et al and Holder by optimizing the rotation speed of the crucible to obtain same by conducting routine experimentation of a result effective variable (MPEP 2144.05). Also, rotating a crucible at 2 rpm is well known in the art, note Nagai et al (US 5,868,835) below. Furthermore, the selection of reaction parameters such as temperature and concentration is obvious (In re Aller 105 USPQ 233, 255 (CCPA 1955)).

Referring to claim 15-18, the combination of Nagai et al and Holder teaches a feed rate of 5-15 kg/hr ('993 claim 14).

Referring to claim 19-31, the combination of Nagai et al and Holder is silent to the value of the f , t_{on} and t_{off} parameters. The combination of Nagai et al and Holder teaches the feeding of silicon by repeatedly commencing and stopping ('395 Abstract) and the feeding of the silicon is such that a constant thickness of unmolten silicon is maintained ('395 col 5, ln 25-40). Therefore,

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the amount of time for commencing and stopping the flow and the flow rate of silicon are result effective variable, which control the thickness of the unmolten layer. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Nagai et al and Holder by optimizing these parameters to obtain same by conducting routine experimentation (MPEP 2144.05).

Referring to claim 32, the combination of Nagai et al and Holder is silent to using an angle of repose valve. Angle of repose valves are conventionally used for granular materials in order to interrupt the flow of granular material. Angle of repose valves are well known in the art, as evidenced by Crawley (US 5,642,751) and Boone et al (US 5,205,998), below.

Referring to claim 33-34, the combination of Nagai et al and Holder teaches a vertical type feed tube so that it is not directly above the center of the exposed unmelted silicon ('993 Figs 2-4).

Referring to claim 35, the combination of Nagai et al and Holder teaches a feed is sprayed ('993 Fig 2-3), this reads on applicant's spray type feed tube.

Referring to claim 36-58, the combination of Nagai et al and Holder teaches a wedge in Figure 3 of Holder because the silicon forms a peak and then tapers toward the crucible in a wedge shape. The combination of Nagai et al and Holder also does not teach the wedge angle. The wedge angle is merely the size of the wedge. Changes in size and shape are held to be obvious (MPEP 2144.03).

Claim Rejections - 35 USC § 103

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Claims 1-102 are rejected under 35 U.S.C. 103(a) as being unpatentable over Holder et al (US 5,588,993) in view of Kamio et al (US 5,087,429).

In a method of preparing a molten silicon melt, note entire reference, Holder teaches polycrystalline silicon **10** is loaded into a crucible **20** and chunk poly crystalline silicon is used because using chunks avoids the formation of void defects (col 3, ln 35 to col 4, ln 2). Holder also teaches polycrystalline silicon **10** is melted until a partially melted charge forms in a crucible (col 4, ln 30-65). After forming the partially melted charge in the crucible, granular polycrystalline silicon **40** is fed onto the exposed unmelted polycrystalline silicon (col 5, ln 1-60). Holder also teaches feeding the polycrystalline silicon **40** on the unmelted silicon **11** allows the silicon to dehydrogenate, which is desirable (col 5, ln 10-30). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Nagai with Holder's method of feeding polycrystalline silicon onto the exposed unmelted polycrystalline to allow the polycrystalline silicon to dehydrogenate before becoming immersed in the molten silicon, which is desirable (col 3, ln 1-15).

Holder et al does not teach intermittent feeding.

In a method of manufacturing silicon single crystals, Kamio et al teaches continuously or intermittently feeding a silicon starting material so as to maintain constant the liquid level of the molten material (col 1, ln 5-67), this reads on applicant's intermittent delivery comprising on and off periods. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Holder by using the feeding apparatus taught Kamio for feeding the silicon intermittently to control a desired flow of silicon material.

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Referring to claim 4-5, the combination of Nagai et al and Holder teach the interface between the unmelted polycrystalline silicon and the upper surface of the molten silicon is approximately equidistant from the center of the unmelted polycrystalline and equidistant from the interior wall of the crucible ('993 Fig 3).

Referring to claims 6-8, the combination of Holder and Kamio et al teach 55 kg of chunk polycrystalline for a 100 kg total charge ('993 col 5, ln 5-15); therefore the percentage of chunk polycrystalline can be determined to be 55% (55/100), which reads on applicant's range of 50-60%.

Referring to claim 9-10, the combination of Holder and Kamio et al teaches the molten silicon comprises about 25-50% of the total surface area ('993 col 4, ln 45-65 and Figs 2-4), this reads on applicant's d ranges about 65%-85% of D.

Referring to claim 11-12, the combination of Holder and Kamio et al teach rotating the crucible ('429 col 6, ln 45-60).

Referring to claim 13-14, the combination of Holder and Kamio et al does not teach rotating at about 2.1 rpm. The rate of crucible rotation is dependant on the flow rate of the feed pipe. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Holder and Kamio et al by optimizing the rotation speed of the crucible to obtain same by conducting routine experimentation of a result effective variable (MPEP 2144.05). Also, rotating a crucible at 2 rpm is well known in the art, note Nagai et al (US 5,868,835) below. Furthermore, the selection of reaction parameters such as temperature and concentration is obvious (In re Aller 105 USPQ 233, 255 (CCPA 1955)).

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Referring to claim 15-18, the combination of Holder and Kamio et al teaches a feed rate of 5-15 kg/hr ('993 claim 14).

Referring to claim 19-31, the combination of Holder and Kamio et al is silent to the value of the f , t_{on} and t_{off} parameters. The combination of Holder and Kamio et al teaches intermittent feeding ('429 col 1) and the feeding of the silicon is such that a constant level is maintained ('429 col 1). Therefore, the amount of time for commencing and stopping the flow and the flow rate of silicon are result effective variable, which control the thickness of the unmolten layer. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Holder and Kamio et al by optimizing these parameters to obtain same by conducting routine experimentation (MPEP 2144.05).

Referring to claim 32, the combination of Holder and Kamio et al is silent to using an angle of repose valve. Angle of repose valves are conventionally used for granular materials in order to interrupt the flow of granular material. Angle of repose valves are well known in the art, as evidenced by Crawley (US 5,642,751) and Boone et al (US 5,205,998), below.

Referring to claim 33-34, the combination of Holder and Kamio et al teaches a vertical type feed tube so that it is not directly above the center of the exposed unmelted silicon ('993 Figs 2-4).

Referring to claim 35, the combination of Holder and Kamio et al teaches a feed is sprayed ('993 Fig 2-3), this reads on applicant's spray type feed tube.

Referring to claim 36-52, the combination of Holder and Kamio et al is silent to portion of the exposed unmelted polycrystalline silicon upon which the granular polycrystalline silicon is delivered is a wedge that extends radially outward from about the center to the interface between

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the unmelted silicon and the upper surface of the molten silicon. However, the combination of Holder and Kamio et al teach rotating at a similar rate and flowing granular silicon intermittently, as applicant, therefore this is inherent to the combination of Holder and Kamio et al. The combination of Holder and Kamio et al also does not teach the wedge angle. The wedge angle is merely the size of the wedge. Changes in size and shape are held to be obvious (MPEP 2144.03).

Referring to claim 53-58, the combination of Holder and Kamio et al is silent to the position of wedges. However, the combination of Holder and Kamio et al teach rotating at a similar rate and flowing granular silicon intermittently, as applicant, therefore this is inherent to the combination of Nagai et al and Holder.

Response to Arguments

5. Applicant's arguments filed 10/18/2004 have been fully considered but they are not persuasive.

Applicant's argument that Nagai does not teaches intermittently delivering additional polycrystalline silicon into the rotating crucible is noted but is not found persuasive. Applicant's allege that Nagai teaches intermittently feeding silicon from a feeder into a feed pipe and Nagai does not teach claim 1 requirement of intermittent delivery of silicon into the growth crucible. Claim 1 recites, " intermittently delivering the additional polycrystalline silicon onto the exposed portion of the unmelted polycrystalline silicon of said partially melted charge in the crucible from which the single crystal silicon is grown", in lines 14-18. Nagai does teach intermittent feeding of silicon from a feeder into a feed pipe, as alleged by applicant. However, as claimed,

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the applicant's invention does not distinguish over the prior art. Applicant requires the feeding of additional polycrystalline only an exposed portion of the partially unmelted polycrystalline silicon in the crucible and the unmelted polycrystalline silicon comprising an exposed portion that is above the upper surface of the molten silicon (claim 1). The unmelted polycrystalline silicon is required to extend from the molten silicon; therefore the unmelted polycrystalline silicon in the feed tube reads on applicant's exposed portion of unmelted polycrystalline silicon even though the unmelted polycrystalline silicon extends into the feed tube. Nagai et al teaches intermittently feeding polycrystalline silicon onto unmelted polycrystalline silicon from which the single crystal silicon ingot is grown; therefore meets the claimed limitation because the feed tube is located in the crucible and the unmelted polycrystalline silicon in the feed tube is used to grow the single crystal ingot.

Applicant's argument that Nagai teaches away from intermittent delivery of silicon into a crucible is noted but is not found persuasive. As discussed previously, the claimed invention does not require intermittent delivery of silicon to the crucible, merely intermittent delivery of silicon to a portion of unmelted silicon in the crucible. Nagai teaches intermittent delivery of silicon to unmelted silicon located in the crucible, which extends into feed tube. Nagai also expressly discloses the commencement and stoppage of feeding silicon, which is required in claim 1.

6. Applicant's arguments with respect to claims 1-102 have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

7. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Ogure et al (US 5,820,649) teaches pelletized silicon material falls intermittently into a silicon melt (col 2, ln 55-65).

Barclay et al (US 5,569,325) teaches the addition of feed material over time can be carried out intermittently in which portion of the feed material are introduced at discrete intervals of time or continuously in which the feed material is being constantly metered.

Nagai et al (US 5,868,835) teaches rotating a crucible at 2 rpm while feeding silicon to silicon melt (col 5, ln 55-67).

Crawley (US 5,642,751) teaches angle of repose valves have typically been used for granular materials in order to interrupt the flow of granular material (col 1, ln 10-15).

Boone et al (US 5,205,998) teaches an angle of repose valve to block the flow for high purity silicon (col 1, ln 50-55 and col 2, ln 1-67).

Holder (US 5,919,303) teaches loading a crucible with chunk polysilicon and granular polysilicon (Abstract).

Fuerhoff (US 6,454,851) teaches a wedge and feeding granular polysilicon and feeding is controlled in response to the relative position to the sidewall of the crucible (Abstract).

8. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Matthew J Song whose telephone number is 571-272-1468. The examiner can normally be reached on M-F 9:00-5:00.

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If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nadine Norton can be reached on 571-272-1465. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Matthew J Song
Examiner
Art Unit 1765

MJS
January 5, 2005

NADINE G. NORTON
SUPERVISORY PATENT EXAMINER

